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PHYSICS.—*The "correction for emergent stem" of the mercurial thermometer.* E. BUCKINGHAM. Communicated by C. W. Waidner. To appear in the Bulletin of the Bureau of Standards.

In defining the scale of the mercurial thermometer it is assumed that the thermometer is all at the same temperature, as is the case with "total immersion" in a bath of uniform temperature. When a thermometer is standardized, the corrections are nearly always stated for total immersion and in terms of the standard gas scale of the laboratory where the test is made. If, subsequently, the thermometer is used with only partial immersion, the mean temperature of the emergent stem will be different from the temperature of the bulb which it is desired to determine; and to allow for this departure from the condition of total immersion, a "stem correction" must be applied to the observed reading before the corrections given by the standardization become applicable.

The length, Δ, of this stem correction is given by the equation

$$\Delta = l\,(t-f)\,\alpha \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

and its value, K, in degrees, by the equation

$$K = nl\,(t-f)\alpha \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

in which n is the number of degrees per unit length of the stem at the level where the reading is made, l is the length of the emergent stem, t is the true temperature of the bulb, and α is the mean

coefficient of apparent expansion of mercury in the glass of which the stem is made between $t°$ and $f°$, both of which are to be expressed in terms of the scale used during the standardization. The correction is often of importance and may in extreme cases exceed 30° C. The two chief methods for determining it are those described by Guillaume and Mahlke.

In Guillaume's method, the quantity Δ is determined directly as a length. An auxiliary stem similar to a portion of the working stem, closed at both ends, partly filled with mercury, and provided with a scale of equal parts, is placed parallel and close to the working stem and with its meniscus at the same level as that in the working stem. The auxiliary stem must be long enough that its lower end reaches into the region of uniform temperature containing the bulb of the main thermometer, and the mean temperature of the mercury column in the auxiliary stem is then very nearly equal to that of the neighboring column of the same length in the working stem. If the auxiliary stem were now totally immersed the change in its reading would evidently be the desired value of Δ.

If the conditions are such that total immersion of the auxiliary stem is possible the determination of Δ becomes extremely simple. The scale reading of the auxiliary stem is taken in the position described above. The instrument is then totally immersed, left a short time to take the temperature of the bath, raised again just far enough for observation of the meniscus, and read immediately. The glass of the stem being thick and a poor conductor, this second reading is very nearly the exact reading for total immersion. The difference of the two readings is the value of Δ in terms of the scale on the auxiliary stem.

If total immersion at the time of use is not possible, the auxiliary stem may be standardized separately and once for all by total immersion in baths of known temperatures, so that its reading for total immersion at any temperature $t°$ may be found from a table. If t, which is the desired temperature, is known approximately, an approximate value of Δ may be found from a single reading and the table. Greater accuracy requires a second approximation by using a corrected value of t. For very accurate

work the auxiliary stem must be made of the same glass as the working stem so that the two may be thermally as well as geometrically similar and similarly placed.

In Mahlke's method the correction is not measured directly as a length but is computed from equation (2). The mean temperature, $f°$, of a length l of the working stem, including the emergent part, is measured by a special "fadenthermometer" devised by Mahlke for this purpose. The fadenthermometer has a long, cylindrical, thick-walled bulb of similar dimensions and construction to a portion of the working stem, and is provided with a still finer graduated capillary stem. When in use, it is placed parallel and close to the working stem, with the upper end of its bulb at the level of the meniscus in the working stem. The length l in equation (2) is thus identical with that of the fadenthermometer bulb. If the fadenthermometer has been standardized by total immersion, its reading gives the mean temperature, $f°$, of its bulb and therefore that of the adjacent length l, of the working stem, for use in equation (2). The fadenthermometer may be regarded as an auxiliary stem provided with a magnifying device —the still finer capillary stem—for increasing the sensitiveness and reducing the reading errors.

The theory of the use of the fadenthermometer presents some difficulties, and the results obtained by it are subject to several small errors which are not easily estimated or determined and which while not of importance in ordinary work, may become so in work of the highest accuracy. In the more extended form of this paper the theory is discussed at some length. In addition, data on the values of α for several thermometer glasses are given in convenient tabular form for practical use, and suggestions are given for the selection of the most suitable fadenthermometer for use in a given piece of work, when several are available.

Careful examination of the relative merits of Guillaume's and Mahlke's methods leads to the conclusion that the fadenthermometer is not an improvement on the simple auxiliary stem of uniform bore, and that its apparent advantages are illusory. For work of moderate accuracy, either method is satisfactory, though Guillaume's method is usually simpler in practice. For work of the highest attainable accuracy, Guillaume's method is to be preferred.

GEOCHEMISTRY.—*Studies in ore deposition with special reference to the sulphides of iron.* E. T. ALLEN, Geophysical Laboratory. Communicated by A. L. Day.

General Principles.—The genesis of ores is essentially a chemical problem. It involves in each individual case the formation of one or more minerals. Barring those rare instances in which the geologist may be able to observe a mineral in the actual process of formation, the conditions of formation have to be inferred from the data obtained by field observation, supplemented by what chemical information is available. At the present time our chemical knowledge of minerals generally embraces something of their behavior toward certain reagents, and often little, if any, more. Accurate data on the genesis of most of them is still wanting. This will have to be accumulated by actually forming the minerals in the laboratory and studying the conditions in systematic fashion. The questions of first importance in mineral synthesis concern, of course, the condition of temperature and pressure and the composition of the systems in which the minerals have formed.

By laboratory study, certain limits to these conditions may be set, outside of which the mineral can not exist, though in general the limits will be wide. Thus if we learn that a certain mineral can not exist above 450°, we know only that the mineral in nature must have formed somewhere between this point and the lowest temperature which prevails in the earth's crust. It is quite probable that we shall be able in many cases to narrow down these temperature limits by the study of paragenesis. Thus if we could determine the temperature limits of two different minerals which, on account of their intergrowth or otherwise, could be shown to have formed at the same time, it would be certain in that particular instance that the minerals formed inside the temperature range which is common to both. Thus far, we have been able to set these temperature limits for comparatively few minerals, chiefly those which are capable of existing in more than one crystal form. Here the temperature is often the most important condition determining *which* crystal form shall appear.

and this characteristic of the mineral may be taken as an index of the temperature which prevailed in its genesis. In a similar way, the composition of original solutions has to a slight extent been determined, since it has been observed that crystal form is sometimes determined by the composition of the solution in which the crystal grew. For the determination of pressure limits, there is at present no method.

In drawing inferences regarding the genesis of natural minerals from experiments in mineral synthesis, one must of course be constantly on guard lest he mistake secondary for essential conditions. It is therefore necessary for the chemist who works in this field to keep in constant touch with the geologists.

The Sulphides of Iron.—In this paper we shall consider the application of some of the above principles to the mineral sulphides of iron which form one of the most important classes of the sulphide ores. The frequent association of these minerals, pyrite, marcasite and pyrrhotite, with other valuable minerals of the sulphide group would indicate that the knowledge of the conditions of the genesis of the former might be applied to the latter as well. Also the association of the different sulphides of iron with one another have suggested several interesting problems of more particular nature which will here be considered.

Pyrite and Marcasite.—Pyrite and marcasite, the disulphides of iron, often occur in such geological formations as to lead to the belief that they were precipitated from cold surface solutions. A typical case of this character is the deposit in the Mississippi Valley. Geologists have reasoned that these and similar deposits have been precipitated from sulphate solutions because surface waters have frequently been observed by them to carry ferrous and ferric sulphates which were formed by the oxidation of older deposits of pyrite or marcasite thru the action of atmospheric influences:

$$FeS_2 + 7\ O + H_2O = FeSO_4 + H_2SO_4.$$

Observation has gone a step farther. Recent pyrite has been observed in wooden conduits, and on the twigs of trees which have fallen into hot springs, and the fact that the same mineral

occurs on coal and sometimes associated with asphalt has led to the conclusion that the ferrous sulphate has been reduced in some way by carbonaceous matter to FeS_2. A disulphide obviously could not be formed by simple reduction, but a more complicated process in which ferrous carbonate would be one of the products may be conceived of. The following equation in a very imperfect way conveys this notion:

$$7\,C + 4\,FeSO_4 = 2\,FeS_2 + 2\,FeCO_3 + 5\,CO_2$$

Omitting details, it may be stated that experiments which have been directed toward the formation of pyrite and marcasite thru the agency of carbonaceous matter have been entirely without result. A possibility of synthesis is suggested by the fact that pyrite and marcasite are very commonly associated with other sulphides of a simpler nature, such as sphalerite and galena which are directly precipitated by hydrogen sulphide. Experiments have in fact shown that both pyrite and marcasite may be obtained by the action of hydrogen sulphide on ferric sulphate solutions. It is well-known that ferric sulphate is directly reduced by hydrogen sulphide to ferrous sulphate with a simultaneous precipitation of sulphur, but it had not previously been noticed that the further action of hydrogen sulphide and sulphur on ferrous sulphate slowly gives rise to a dark precipitate having the composition FeS_2. This reaction, which we may represent by the equation

$$FeSO_4 + H_2S + S = FeS_2 + H_2SO_4$$

takes place even at ordinary temperature, though quite slowly. A microscopic examination of product proves that it is distinctly crystalline, tho the crystals are minute. If the reaction is allowed to go on at a sufficiently high temperature in a sealed glass tube, say 200° C., the crystals grow large enough to measure, and it has been found that they are partly marcasite—a mineral which has not previously been made artificially. A method was devised by H. N. Stokes for the analysis of mixtures of natural pyrite and marcasite which we have used to great advantage on the laboratory products. It consists in the oxidation of the

sulphides by a dilute solution of ferric sulphate. The products of the reaction are ferrous sulphate, sulphur, and sulphuric acid for both minerals, but the relative quantities of the products are decidedly different. Only 14 per cent of the sulphur in marcasite is thus oxidized to sulphuric acid, the rest being precipitated as free sulphur, while 56 per cent of the sulphur in pyrite is oxidized. It is thus possible to determine in any mixture of the two sulphides the percentage of each. As was stated above, the action of hydrogen sulphide on a mixture of ferrous sulphate and sulphur gives in general a mixture of both pyrite and marcasite, and the application of Stokes' method has proved that there are two essential conditions which determine the proportions of the two; these are temperature and acidity. The higher the temperature during the reaction, the greater is the percentage of pyrite obtained. It is also true that the lower the acidity of the solution, the greater is the percentage of pyrite formed, until, when the solution becomes neutral or alkaline, the product is practically all pyrite. The equation on p. 172 shows that it is not possible to maintain the solution neutral when hydrogen sulphide acts on ferrous sulphate and sulphur, for sulphuric acid is one of the products, but if we substitute suspended ferric hydroxide for the ferrous salt, the solution remains neutral, if we waive the question of the weakly acid nature of hydrogen sulphide itself. Another way in which we can command the same essential conditions is to heat pyrrhotite or ferrous sulphide with free sulphur and a water solution of hydrogen sulphide which contains a very little sodium bicarbonate. This solution dissolves and carries over the sulphur to the pyrrhotite, thus forming FeS_2 in a practically neutral solution and the result is pyrite.

An alkaline solution of sodium polysulphide precipitates from a ferrous salt an amorphous mixture of ferrous sulphide and sulphur, but these combine slowly under the influence of heat, and probably, even at the ordinary temperature, with the formation of pyrite.[1] These data enable us to draw some important

[1] At the lower temperatures (100°) amorphous disulphide appears to be the first product.

conclusions relating to the formation of these minerals in nature. (1) We know that the mineral marcasite can be formed by the action of hydrogen sulphide on ferric sulphate solutions, or, what comes to the same thing, a solution containing ferrous sulphate[2] and hydrogen sulphide to which the air finds some access. If the solution contains as much as 1 per cent of free sulphuric acid and the temperature is not above 100°, the product is all marcasite. It is also not improbable that pure marcasite can form at a higher temperature if the solution is still more acid. Now, these conditions agree strikingly with what we find about the genesis of marcasite from field study. It is always a surface mineral, presumably formed from surface solutions at *low* temperatures. It is also a matter of common knowledge that such solutions when they contain iron usually carry it in the form of sulphate, together with sulphuric acid, since they result from the oxidation of an older body of pyrite or marcasite. (2) We know that pyrite forms from solutions which are neutral or alkaline by the action of alkaline polysulphides on ferrous salts and by the action of hydrogen sulphide on ferric hydroxide. Both reactions are essentially the union of ferrous sulphide and sulphur in a neutral or alkaline medium. Coming again to the deductions from field observation, it is found that pyrite is always deposited by hot waters instead of marcasite, and that deep veins which formed under comparatively high temperatures also contain pyrite, never marcasite. Now, hot terrestrial waters are practically always alkaline, not only because silicates are hydrolized by hot waters with the necessary formation of an alkaline solution,[3] but because if a strong acid were allowed to act on rocks at the high temperatures which prevail in the depths of the earth's crust, chemical action would soon neutralize it by the decomposition of carbonates, silicates, etc. (3) Pyrite and marcasite form together when hydrogen sulphide acts on ferric sulphate unless the percentage of free acid and the temperature are

[2] It is not essential to use the *sulphate;* any other ferrous salt will suffice.

[3] This, of course, postulates the presence of some alkali or alkaline earth metal in the rocks, but some of these metals are practically always present.

sufficiently low. The quantity of free sulphuric acid must be about 1 per cent at 100° to insure the formation of marcasite free from pyrite, while at 300° it must be considerably more, if indeed it is possible to get a product free from pyrite at that temperature. Pyrite and marcasite are very commonly found together in nature, often in the same hand specimen and sometimes intergrown. Altho in some cases the two minerals probably belong to different periods of deposition, it seems entirely probable, in view of the laboratory results, that in other cases they are contemporaneous.

The Relation of Marcasite to Pyrite.—When marcasite is heated to a temperature of 450° C., under conditions which preclude oxidation, it changes to pyrite. Not only does its color become yellower and its density higher (the density of marcasite is 4.889, that of pyrite 5.02), but its behavior with a ferric sulphate solution proves conclusively that it has become pure pyrite; for while at the start the ferric sulphate oxidized only 14 per cent of the sulphur of all the marcasite it decomposed, now it oxidizes 56 per cent. In a comparatively simple way, it can be shown that heat is set free during this change, which proves, of course, that marcasite possesses more energy than pyrite. Pyrite cannot be changed directly into marcasite, *i.e.*, the change is irreversible and marcasite is what is called a monotropic form. The question of the chemical constitution of the two forms will not be discussed here, except that it may be remarked that they *appear* to be polymorphic forms in which the difference is one of crystalline structure rather than of a chemical nature. More important for the problems of ore deposition is the significance of the temperature at which the change occurs. It goes on at 450° very slowly and could not be detected at 400° in a period of four hours. It will be observed, therefore, that marcasite cannot have formed in nature above 450° and any minerals which can be shown to have been precipitated at the same time with marcasite are subject of course to the same limitation. Pressure can not be invoked to qualify this statement, for a pressure of several thousand atmospheres was found not to accelerate the change. We may also conclude that a paramorph of pyrite after marcasite would show that the

original crystal had been subjected to a temperature the lower limit of which lies somewhere between 350° and 450°, because at 300° marcasite crystals were found not to be changed to pyrite, either by acid or alkaline solutions.

Pyrrhotite can be readily formed by the decomposition of pyrite in hydrogen sulphide at temperatures above 575°. The higher the temperature is carried, the more sulphur is lost, and a product formed at high temperatures, say at 800° to 1100° C., takes up more sulphur when heated in hydrogen sulphide below that temperature. Although it is somewhat aside from the main purpose, of this article, viz., to discuss certain problems of ore deposition, it may nevertheless be of sufficient interest to remark in regard to the mooted question of the true chemical formula for pyrrhotite, that this mineral is really variable in composition, at the same time preserving its homogeneity; in other words, ferrous sulphide can dissolve a quantity of sulphur depending on the temperature like any other solubility. At 600° the maximum quantity dissolved is 6.0 per cent. We may if we please represent such a solid solution by the formula $(FeS)S_x$.

Under the experimental conditions thus far tested (*i.e.*, heating pyrrhotite in dry H_2S) a solution containing only about 6.0 per cent can be obtained after which further sulphur changes pyrrhotite into pyrite. The pyrrhotite of nature doubtless formed from solution, yet it is remarkable that the highest percentages of sulphur in the natural mineral range in the neighborhood of 6 per cent dissolved sulphur (*i.e.*, about 40 per cent of total sulphur).

Geological observation leads to the conclusion that vein forming solutions, doubtless polysulphides, change pyrrhotite to pyrite, and phenomena are observed about contacts which lead to the belief that the reverse action, the decomposition of pyrite into pyrrhotite and sulphur, occurs. In the neighborhood of contact intrusive masses, where the sulphides of iron occur, pyrrhotite is found close to the contact where the temperature was highest and pyrite in the colder zones. It is commonly held by geologists that in nature pyrrhotite was formed from the same solutions as silicates like olivine and augite. The experimental difficulties are at present too great to attack this question.

In conclusion, the author wishes to express his indebtedness to Drs. J. L. Crenshaw and John Johnston, and Mr. Esper Larsen, in collaboration with whom the experimental data for this article were worked out; and to Dr. F. L. Ransome and W. H. Emmons, and especially to W. Lindgren, for geological data.

MINERALOGY.—*A study of the rutile group.* WALDEMAR T. SCHALLER. To appear in a bulletin, "Mineralogical Notes, Series II." of the U. S. Geological Survey.

A theoretical study is made of the minerals comprising the rutile group—rutile, cassiterite, mossite, tapiolite, nigrine, iserite, ainalite, ilmenorutile and strüverite. It is shown that they are all either members or mixtures of members of a group of "primary compounds", of which there are six chief ones, namely, ferrous columbate $Fe(CbO_3)_2$, ferrous tantalate $Fe(TaO_3)_2$, ferrous titanate $Fe(TiO_3)$, titanyl titanate $(TiO)(TiO_3)$, stannyl stannate $(SnO)(SnO_3)$ and ferrous stannate $Fe(SnO_3)$. A study of all the available analyses of these minerals proves the validity of the assumptions made and it is concluded that of these minerals only three, tapiolite, rutile and cassiterite, are definite species. Ilmenorutile (and strüverite from Italy) is an isomorphous mixture of compounds, in which iron, tantalum, columbium, and titanium are present in quantity; strüverite from South Dakota is a columbic ilmenorutile; mossite is a columbic tapiolite; nigrine and iserite are ferrous rutiles; ainalite is tantalic cassiterite; and the various cassiterites from Mexico are ferrous cassiterites, arsenical cassiterites, etc.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this journal and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

TERRESTRIAL MAGNETISM.—*Magnetic chart errors and secular changes in the Indian Ocean.* L. A. BAUER and W. J. PETERS. Journal of Terrestrial Magnetism and Atmospheric Electricity. 1911.

This article gives a summary of the magnetic declinations together with geographic positions as determined on the *Carnegie* during her recent cruise from Cape Town to Colombo, Ceylon, and thence to Mauritius, in April to August, 1911. The tables of values are supplemented by the corresponding values scaled from a British Admiralty chart of 1907, the German chart of 1910, and the United States Hydrographic Office chart of 1910, these values being referred approximately to the time of observation by secular changes as indicated on the respective charts. The differences between the *Carnegie* values and those of the various charts are given. With the exception of a few values during the first part of the cruise from Cape Town the chart errors are always negative, that is to say, the chart values are too low and hence a value of west declination scaled from any of the charts mentioned must be increased to make it correspond with that of the *Carnegie*. The errors are unusually large, running up at times to 4°, and for one of the charts is even as much as 6°. These chart errors, while partly due to the defective spacing of the lines of equal magnetic declination, are to be referred chiefly to erroneous secular changes applied to the previous data on which the charts depend.

From a comparison of the *Carnegie* values with those of the German Antarctic ship, the *Gauss*, made in 1903 by Dr. Bidlingmaier, secular variation data may be obtained. The following values for secular change result from the consideration of means at points common to the two vessels. For the region of the mean south latitude 37° 29′ and east

longitude 25° 52′, the average annual change is −10′.9; for the region of the mean south latitude 35° 16′ and east longitude 74° 46′ the mean average annual change is +13′.2; and for the region of the mean south latitude 25° 17′ and east longitude 60° 35′ the average annual change is +5′.4. The mean secular changes corresponding, as taken from the British Admiralty chart and the United States Hydrographic Office chart above referred to, are respectively −2′.5, +2′.5, −2′.2. The plus sign attached to the secular change indicates that west declination is at present increasing for the locality, the minus sign meaning of course the reverse. It will be noticed that the charts give considerably smaller values, and in the last case values of reversed sign. The large changes and the rapid variation with geographic position are to be especially noted.

The errors of the charts in magnetic inclination reach a maximum of about 3 degrees and in horizontal intensity of a unit in the second decimal C.G.S. J. A. FLEMING.

TERRESTRIAL MAGNETISM.—*Comparisons of magnetic observatory standards by the Carnegie Institution of Washington.* J. A. FLEMING. No. 1. Journal of Terrestrial Magnetism and Atmospheric Electricity, **16**: 61–84, pl. IV. 1911. No. 2. To appear in same Journal.

A summary is given of the intercomparison observations made at various magnetic observatories throughout the world by the Department of Terrestrial Magnetism for March, 1911. The accuracy striven for is such that will be sufficient for ordinary magnetic survey purposes and for this reason the intercomparisons are made with the usual field instruments and methods and in the course of regular field work as opportunity permits. Detailed descriptions of the various instruments used and their constants are given. The methods of observation followed are according to the usual scheme of work at land stations, no elaboration except in number being attempted.

The corrections of each instrument used are all referred to the provisional international magnetic standards of the Department.[1] These corrections are determined by observations at Washington, which are made practically under the same conditions as prevail in the field and involve simultaneous observations with both the standard instrument

[1] Bauer, L. A., Preliminary note on International Magnetic Standard. Terr. Mag., **12**: 161-165. 1907.

and the one being compared, as well as the interchange of instruments and observers between the stations, in order that there may be no uncertainty from ignorance of the precise station difference, if any, due to local attraction, either natural or an unsuspected artificial one. Specimens of such intercomparisons are given in detail.

The intercomparisons reported upon were made at the following observatories: Sitka, Alaska; Potsdam, Germany; Kew, England; Falmouth, England; Pola, Austria; Toronto, Canada; Tiflis, Russia in Europe; Tashkent, Russia in Asia; Baldwin, United States; Cheltenham, United States; Zi-ka-wei, China; Dehra Dun, India; Helwan, Egypt; Havana, Cuba; Hongkong, China; Honolulu, Hawaii; Vieques, Porto Rico; Alibag, India; Apia, Samoa; Pilar, Argentine Republic; Sydney and Melbourne, Australia; Christchurch, New Zealand. By means of the results obtained by the Department at Kew and Potsdam further intercomparisons of observatory standards are obtained indirectly through the recent work of Dubinsky and Kühl at additional observatories as follows: Upsala, Sweden; Pavlovsk and Katharinenburg, Russia in Europe; Rude Skov, Denmark; Irkutsk, Russia in Asia; de Bilt, Netherlands; and Val Joyeux, France. The indirect comparisons are of especially great interest because of the conception given by them of the relative precision obtainable with entirely different types of instruments and independently determined constants.

From a summary of the comparisons it appears that the provisional standard adopted by the Department in declination is perhaps from 0.3 to 0.5 minute too high for east declination; in dip a corresponding amount too low in northerly inclination; and in horizontal intensity as much as 0.0001H to 0.0002H too high. The probable errors of the determinations are quite small, rarely exceeding 0.1 minute in declination, 0.3 minute in inclinations, and 0.00005H in horizontal intensity. The uncertainties involved in reductions for diurnal variation are much larger than the order of the probable errors but they may be considerably reduced by suitably selecting the time for observation. J. A. F.

CHEMISTRY.—*Assay of Lactic Acid.* ELIAS ELVOVE, Hygienic Laboratory, Public Health and Marine Hospital Service. American Journal of Pharmacology, **83**: 14–19. 1911.

The United States Pharmacopœia specifies a lactic acid containing 75 per cent of true lactic acid and having a specific gravity of 1.206 at 25° C. An acid of this specific gravity should contain about 85 per cent of true lactic acid. This anomalous specification is due to the inaccuracy of the pharmacopœial method of estimation, which involves

direct titration of the boiling acid. In the procedure which is recommended, 50 cc. of normal sodium hydroxide are added to about 2 grams of the acid and the excess of alkali is titrated with normal sulphuric acid after the mixture has remained for thirty minutes at ordinary temperature, using phenolphthalein as indicator. E. E.

CHEMISTRY.—*Use of sulphur dioxide in checking strengths of volumetric solutions of iodine, alkali, and silver.* ELIAS ELVOVE, Hygienic Laboratory, Public Health and Marine Hospital Service. American Journal of Pharmacology, **83**: 19–23. 1911.

A scheme is outlined for basing the determination of the strengths of volumetric solutions on pure silver as a standard. The solutions would be prepared in the following order, each serving as a standard for the succeeding one: ammonium thiocyanate (standardised against pure silver), silver nitrate, hydrochloric acid, sodium hydroxide, oxalic acid, potassium permanganate, sodium thiosulphate, iodine. To control the standardisation, 25 cc. of the standard iodine solution is just decolorised by freshly prepared sulphur dioxide solution and the acid formed titrated with the standard sodium hydroxide solution. The total iodide in this neutralised solution could then be determined by adding excess of silver nitrate and titrating the excess of silver with standard ammonium thiocyanate, allowance being made for the pure potassium iodide used in preparing the iodine solution. E. E.

AGRICULTURAL CHEMISTRY.—*The toxic action of organic compounds as modified by fertilizer salts.* OSWALD SCHREINER and J. J. SKINNER. Science, **33**: 340. 1911.

The action of fertilizer salts in restraining the harmful influence of certain organic compounds was studied, as well as the effect of the compounds on absorption. The culture solutions comprised all possible ratios of the three principal fertilizer elements; phosphate, nitrate and potassium, varying in 10 per cent stages.

The various fertilizer salts acted differently in overcoming the respective harmful effects of the toxic compounds. The mainly phosphatic fertilizers were the most efficient in overcoming the cumarin effects; the mainly nitrogenous fertilizers in overcoming the vanillin effects; the mainly potassic in overcoming the quinone effects.

The cumarin depressed potash and nitrate removal from nutrient solution more than phosphate; the quinone, on the other hand, depressed phosphate and nitrate more than potash; the effect of vanillin was not determined in this regard. Dihydroxystearic acid, which, as previously

reported appears to act much as does vanillin, depressed phosphate and potash more than nitrate. In this respect again the influence of the various harmful substances is different.

The conclusion is drawn that different toxic substances produce definite effects in their action on plants and that the effects are modified differently by the different fertilizer salts. M. X. SULLIVAN.

AGRICULTURAL CHEMISTRY.—*Biochemical factors in soil.* M. X. SULLIVAN. Science, **33**: 543. 1911.

The soil is not an inert reservoir for plant food but is the seat of physical, chemical and vital actions, the biochemical factors being especially prominent. Numerous bodies which occur in soils and arise either in the metabolic activities of micro-organisms or are left in the soil after the decomposition of the plant and animal débris and perhaps offer also as a result of excretion from roots or from cell sloughing, play a considerable rôle in soil fertility. Some of these substances are harmful to plants, some beneficial. Fertilizers modify the physiological functions of the micro-organisms by bringing about suitable conditions for their development, in stimulating or retarding their digestion of inert bodies, and in furthering their enzymotic functions. Soils *per se* have oxidizing and catalyzing properties, while poor soils have these functions in a much lessened degree. Oxidation in subsoils, which are of much poorer productivity than surface soil, is usually slight. M. X. S.

PHARMACOLOGY.—*The pharmacopœial standard for desiccated thyroid glands.* REID HUNT and ATHERTON SEIDELL, Hygienic Laboratory, Public Health and Marine Hospital Service. American Journal of Pharmacy, **83**: 407–411 (Sept.) 1911.

The parallelism between the iodine content and physiological activity of thryoid having been established, the authors call attention to the advantages of the method of Hunter (J. Biol. Chem., **7**: 321–349. 1910), over the older Baumann method for the estimation of the organically combined iodine of thyroid, and suggest the incorporation of the Hunter method in the pharmacopoeial description of this drug. On the basis of the analysis of a large number of commercial desiccated thyroid samples, a standard iodine content of 0.2 per cent, with a maximum variation of 0.03 per cent above or below this figure is recommended. The limit for moisture is placed at 6 per cent, and that for ash at 5 per cent. Attention is called to the improbability of the claim that some recently prepared thyroid preparations contain thyroid iodine compound in a super active form. A. S.

GEOLOGY.—*Geology and underground waters of northeastern Texas.* C. H. GORDON. Water-Supply Paper U. S. Geological Survey No. 276. Pp. 78, with maps, sections, and views. 1911.

Geologic formations that outcrop are (1) upper Cretaceous, (2) lower Tertiary, and (3) surficial deposits. In addition there are sands, silts, and clays of Pleistocene age and the flood-plain deposits of the present streams. Seven water-bearing horizons have been recognized, ranging in age from lower Cretaceous to Eocene.

Warping of the old Jurassic land-surface, which preceded and accompanied the deposition of later formations, gave the beds a gentle slope toward the Gulf of about 55 feet per mile.

Upon the upper Cretaceous beds in the south half of the district, without recognized stratigraphic break, lie sands, clays, and ferruginous sandstones belonging to the Eocene. At the beginning of the Eocene slight warping enlarged the Mississippi embayment, causing overlap of early Eocene beds upon the Cretaceous contemporaneous with marked change in fauna. During Eocene time near-shore or swampy conditions prevailed with an occasional submergence by the ocean. No Oligocene or Miocene deposits have been recognized. The Miocene was essentially a period of erosion, and if deposits of Oligocene age were laid down they were afterwards removed. During the Pliocene a mantle of sand, silt, and gravel was spread over the eroded surface, and was in turn eroded. Further Pleistocene deposition succeeded, giving rise to marine and fluviatile (Port Hudson formation) deposits. Erosion followed again, leaving the present flood plains and principal terraces.

H. D. MCCASKEY.

GEOLOGY.—*Sewickley, Pa., Folio.* M. J. MUNN. Geologic Atlas of the United States, No. 176. Pp. 16, with maps and sections. U. S. Geological Survey. 1911.

Outcropping formations include the Allegheny, Conemaugh and Monongahela, of the Pennsylvanian series of the Carboniferous, and aggregate about 800 feet in thickness. Deep borings indicate 1200 feet of underlying Devonian and Carboniferous strata. The dip is south-southeast, at about 50 feet to the mile. Detailed study of the oil sands indicates greater folding in the older buried beds than in those above. It is suggested that the pre-Pottsville rocks were slightly folded during the early Pottsville uplift, developing lines of weakness followed by the post-Carboniferous folds. The Pleistocene is represented by four terrace formations, of which all but the oldest are outwash glacial gravels.

H. D. MCCASKEY.

ECONOMIC GEOLOGY.—*Reconnaissance of the ore deposits of northern Yuma County, Arizona.* HOWLAND BANCROFT. Bulletin U. S. Geological Survey No. 451. Pp. 130, with maps, sections, and views. 1911.

The oldest rocks are granites and gneisses, probably Archaean, together with a group of highly altered sediments, with some igeneous rocks, cut by numerous intrusives of pre-Cambrian age. Some massive granite is provisionally assigned to the Mesozoic, and a series of volcanics with some sediments is regarded as Tertiary. Quaternary deposits are represented by conglomerate and basalt.

Mineralization took place in the pre-Cambrian, Mesozoic, and Tertiary periods.

Auriferous quartz veins and mineralized shear zones occur in the pre-Cambrian rocks. Another type of auriferous deposit, also of pre-Cambrian age, is represented by quartz siderite stringers in amphibolite schists and limestones. The largest deposits of copper and iron occur as irregular veins in shear zones in the amphibolitic and chloritic rocks and as replacements of limestone. Copper also occurs in shear zones and fissure veins in the Archaean gneiss and as fissure veins in the Tertiary lavas. Contact-metamorphic copper deposits are found in the zones of metamorphism between the limestones and Mesozoic intrusives.

A. H. BROOKS.

HYDROLOGY.—*The quality of the surface waters of Illinois.* W. D. COLLINS. Water-Supply Paper U. S. Geological Survey, No. 239. Pp. 94, 3 plates. 1910.

A coöperative investigation was conducted in 1906 and 1907 by the United States Geological Survey, the State Water Survey of Illinois, the engineering experiment station of the University of Illinois, and the State Geological Survey of Illinois for the study of the chemical composition of Illinois waters, their action on boilers, the purification of them for industrial and domestic use, and other similar problems. Stations were established on the principal rivers and reservoirs of the State at 26 places where daily samples of water were collected for one year for mineral analysis. The report discusses these analyses in relation to the sources of the mineral matter, its effect in economic uses of the water, and the cost methods of reducing its quantity. A noteworthy feature is the correlation of mineral content with stream discharge, typified by the computations of the relative components of Mississippi River at Chester. The physical and economic conditions that affect the quality of the waters are considered especially in reference to trades wastes.

The paper is concluded by tables of 700 analyses of water made during the study. It is a source of definite detailed information regarding the chemical composition of the surface waters of Illinois. R. B. DOLE.

BOTANY.—*Inheritance of the "eye" in Vigna.* W. J. SPILLMAN. American Naturalist, **45**: Sept. 1911.

Certain races of the cowpea (*Vigna unguiculata*) have the seed coat pigmented only in certain areas. In all such cases the pigmented area includes the region about the hilum and is called the eye. It varies widely in size and form.

Genetic studies of these races has demonstrated that there are two genetically distinct types of eye, both recessive. When the two types of eye are brought together in the same individual by proper cross-breeding, the resulting form of eye is that of the common eyed races of peas, in which there is a small pigmented area about the hilum. One type, without the other, gives a pigmented area covering something over half the surface of the seed; the other type alone gives a pigmented area about the hilum, the edges of the area being indistinct, fine dots of pigment extending into the unpigmented area and covering the micropilar end of the seed.

It is shown that four different hypotheses regarding the nature of the hereditary factors responsible for the eye are in accord with the genetic behavior of the characters in question. W. J. S.

TECHNOLOGY.—*The diffusion of crude petroleum through fuller's earth, with notes on its geologic significance.* J. ELLIOTT GILPIN and OSCAR E. BRANSKY. Bulletin U. S. Geological Survey No. 475. Pp. 50. 1911.

When a solution of benzene and a paraffin oil diffuses upward through a tube packed with fuller's earth, the benzene collects below and the paraffin oil above. When crude petroleum diffuses a fractionation occurs. The oil from the top of the tube possesses a lower specific gravity than that from the bottom. As the fractionation proceeds the range of specific gravity covered becomes smaller, indicating the production of mixtures which will finally pass through the earth unaltered. The amounts of unsaturated hydrocarbons and sulphur compounds in the fractions increase gradually from the lightest oils above to the heavier oils below.

Fuller's earth retains the unsaturated hydrocarbons and sulphur compounds in petroleum, thus exercising a selective action upon the oil. H. D. MCCASKEY.

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Results of spirit leveling in West Virginia, 1909 and 1910. R. B. MARSHALL Bulletin U. S. Geological Survey No. 477. Pp. 54. 1911.

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